

General Description

The MAX6126 is an ultra-low-noise, high-precision, lowdropout voltage reference. This family of voltage references feature curvature-correction circuitry and high-stability, laser-trimmed, thin-film resistors that result in 3ppm/°C (max) temperature coefficients and an excellent ±0.02% (max) initial accuracy. The proprietary low-noise reference architecture produces a low flicker noise of 1.3µV_{P-P} and wideband noise as low as 60nV/√Hz (2.048V output) without the increased supply current usually found in low-noise references. Improve wideband noise to 35nV/\(\sqrt{Hz}\) and AC power-supply rejection by adding a 0.1µF capacitor at the noise reduction pin. The MAX6126 series mode reference operates from a wide 2.7V to 12.6V supply voltage range and load-regulation specifications are guaranteed to be less than 0.025Ω for sink and source currents up to 10mA. These devices are available over the automotive temperature range of -40°C to +125°C.

The MAX6126 typically draws 380µA of supply current and is available in 2.048V, 2.500V, 2.800V, 3.000V, 4.096V, and 5.000V output voltages. These devices also feature dropout voltages as low as 200mV. Unlike conventional shunt-mode (two-terminal) references that waste supply current and require an external resistor. the MAX6126 offers supply current that is virtually independent of supply voltage and does not require an external resistor. The MAX6126 is stable with 0.1µF to 10µF of load capacitance.

The MAX6126 is available in the tiny 8-pin µMAX®, as well as 8-pin SO packages.

Applications

High-Resolution A/D and D/A Converters

ATE Equipment

High-Accuracy Reference Standard

Precision Current Sources

Digital Voltmeters

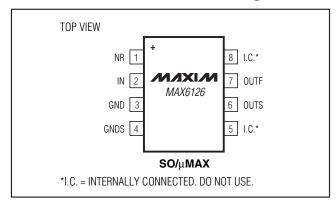
High-Accuracy Industrial and Process Control

μΜΑΧ is a registered trademark of Maxim Integrated Products, Inc.

Features

- ♦ Ultra-Low 1.3µVp-p Noise (0.1Hz to 10Hz, 2.048V **Output)**
- ♦ Ultra-Low 3ppm/°C (max) Temperature Coefficient
- ♦ ±0.02% (max) Initial Accuracy
- ♦ Wide (Vout + 200mV) to 12.6V Supply Voltage Range
- ♦ Low 200mV (max) Dropout Voltage
- ♦ 380µA Quiescent Supply Current
- ◆ 10mA Sink/Source-Current Capability
- ♦ Stable with C_{LOAD} = 0.1μF to 10μF
- ♦ Low 20ppm/1000hr Long-Term Stability
- ♦ 0.025Ω (max) Load Regulation
- ♦ 20µV/V (max) Line Regulation
- **♦** Force and Sense Outputs for Remote Sensing

Pin Configuration



Ordering Information

PART	TEMP RANGE	PIN- PACKAGE	OUTPUT VOLTAGE (V)	MAXIMUM INITIAL ACCURACY (%)	MAXIMUM TEMPCO (-40°C to +85°C) (ppm/°C)	TOP MARK
MAX6126AASA21+	-40°C to +125°C	8 SO	2.048	0.02	3	_
MAX6126BASA21+	-40°C to +125°C	8 SO	2.048	0.06	5	_
MAX6126A21+	-40°C to +125°C	8 µMAX	2.048	0.06	3	6126A21

Ordering Information continued at end of data sheet.

+Denotes a lead(Pb)-free/RoHS-compliant package.

ABSOLUTE MAXIMUM RATINGS

(All voltages referenced to GND)
GNDS0.3V to +0.3V
IN0.3V to +13V
OUTF, OUTS, NR0.3V to the lesser of $(V_{IN} + 0.3V)$ or +6V
Output Short Circuit to GND or IN60s
Continuous Power Dissipation ($T_A = +70^{\circ}C$)
8-Pin µMAX (derate 4.5mW/°C above +70°C)362mW
8-Pin SO (derate 5.88mW/°C above +70°C)471mW

Operating Temperature Range	40°C to +125°C
Junction Temperature	+150°C
Storage Temperature Range	65°C to +150°C
Lead Temperature (soldering, 10s)	+300°C
Soldering Temperature (reflow)	

Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

ELECTRICAL CHARACTERISTICS—MAX6126_21 (Vout = 2.048V)

 $(V_{IN} = 5V, C_{LOAD} = 0.1 \mu F, I_{OUT} = 0, T_A = T_{MIN} \text{ to } T_{MAX}, \text{ unless otherwise noted. Typical values are at } T_A = +25^{\circ}C.)$

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS		
OUTPUT	'	•			•				
Output Voltage	Vout	T _A = +25°C				2.048		V	
			A grade	e SO	-0.02		+0.02		
Output Voltage Accuracy		Referred to	B grade	e SO	-0.06		+0.06	%	
Output Voltage Accuracy		V _{OUT} , T _A = +25°C	A grade	e µMAX	-0.06		+0.06	70	
		1,4 1,20 0	B grade	e µMAX	-0.1		+0.1		
			A grade	e SO		0.5	3		
		T _A = -40°C	B grade	e SO		1	5		
Output Voltage Temperature Coefficient (Note 1)		to +85°C	A grade	e µMAX		1	3	ppm/°C	
	TCV _{OUT}		B grade	e µMAX		2	7		
	10,001	T _A = -40°C to +125°C	A grade	e SO		1	5		
			B grade	e SO		2	10		
	ļ		A grade	e µMAX		2	5		
			B grade	e µMAX		3	12		
Line Degulation	ΔV _{OUT} /	2.7V ≤ V _{IN} ≤	$T_A = +2$	25°C		2	20		
Line Regulation	ΔV_{IN}	12.6V	$T_A = -4$	0°C to +125°C			40	μV/V	
Load Regulation	ΔV _{OUT} /	Sourcing: 0 ≤	I _{OUT} ≤ 10i	mA		0.7	25	11) //m A	
Load Regulation	Δlout	Sinking: -10m.	A ≤ I _{OUT} :	≤ 0		1.3	25	μV/mA	
OUT Short-Circuit Current	la a	Short to GND				160		mA	
OOT SHORT-CITCUIT CUITERIT	I _{SC}	Short to IN				20		MA	
Thermal Hystorogic (Note 2)	ΔV _{OUT} /	SO				25		nnm	
Inermal Hysteresis (Note 2)		μМΑХ	μMAX			80		ppm	
Long Torm Stability	ΔV _{OUT} /	1000br at T	1.25°C	SO		20	ppm/		
Long-Term Stability	time	TOUUTII at IA=	1000hr at $T_A = +25^{\circ}C$			100		1000hr	

ELECTRICAL CHARACTERISTICS—MAX6126_21 (Vout = 2.048V) (continued)

 $(V_{IN} = 5V, C_{LOAD} = 0.1 \mu F, I_{OUT} = 0, T_A = T_{MIN} \text{ to } T_{MAX}, \text{ unless otherwise noted. Typical values are at } T_A = +25 ^{\circ}C.)$

PARAMETER	SYMBOL	CONDIT	IONS	MIN	TYP	MAX	UNITS	
DYNAMIC CHARACTERISTICS								
		f = 0.1Hz to 10Hz			1.3		μV _{P-P}	
Noise Voltage	eout	$f = 1kHz, C_{NR} = 0$			60		nV/√Hz	
		$f = 1kHz$, $C_{NR} = 0.1\mu F$			35			
Turn On Sattling Time	t _R	To V _{OUT} = 0.01% of	$C_{NR} = 0$		0.8		ms	
Turn-On Settling Time		final value	$C_{NR} = 0.1 \mu F$		20			
Capacitive-Load Stability Range	C _{LOAD}	No sustained oscillation	าร		0.1 to 10		μF	
INPUT								
Supply Voltage Range	V _{IN}	Guaranteed by line-reg	ulation test	2.7		12.6	V	
Quiggaent Supply Current	I _{IN}	T _A = +25°C			380	550		
Quiescent Supply Current		$T_A = -40$ °C to $+125$ °C				725	μΑ	

ELECTRICAL CHARACTERISTICS—MAX6126_25 (Vout = 2.500V)

 $(V_{IN} = 5V, C_{LOAD} = 0.1 \mu F, I_{OUT} = 0, T_A = T_{MIN}$ to T_{MAX} , unless otherwise noted. Typical values are at $T_A = +25 ^{\circ}C$.)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
ОИТРИТ							
Output Voltage	Vout	T _A = +25°C			2.500		V
			A grade SO	-0.02		+0.02	
Output Valtage Assurage		Referred to V _{OUT} ,	B grade SO	-0.06		+0.06	%
Output Voltage Accuracy		T _A = +25°C	A grade µMAX	-0.06		+0.06	76
			B grade μMAX	-0.1		+0.1	
		$T_A = -40^{\circ}C \text{ to } +85^{\circ}C$	A grade SO		0.5	3	ppm/°C
			B grade SO		1	5	
			A grade µMAX		1	3	
Output Voltage Temperature	TOVOLIT		B grade μMAX		2	7	
Coefficient (Note 1)	TCV _{OUT}		A grade SO		1	5	
		$T_A = -40^{\circ}C$ to	B grade SO		2	10	
		+125°C	A grade μMAX		2	5	
			B grade μMAX		3	12	
Line Degulation	ΔV _{OUT} /	0.7\/ -\/10.6\/	T _A = +25°C		3	20	\/\/
Line Regulation	ΔVIN	$2.7V \le V_{ N } \le 12.6V$	$T_A = -40^{\circ}C \text{ to } +125^{\circ}C$			40	μV/V
Lood Regulation	ΔV _{OUT} /	Sourcing: 0 ≤ I _{OUT} ≤ 10mA			1	25	\//m ^
Load Regulation	Δl _{OUT}	Sinking: -10mA ≤ I _{OU}	Sinking: -10mA ≤ I _{OUT} ≤ 0		1.8	25	μV/mA

ELECTRICAL CHARACTERISTICS—MAX6126_25 (Vout = 2.500V) (continued)

 $(V_{IN} = 5V, C_{LOAD} = 0.1 \mu F, I_{OUT} = 0, T_A = T_{MIN}$ to T_{MAX} , unless otherwise noted. Typical values are at $T_A = +25 ^{\circ}C$.)

PARAMETER	SYMBOL	CONDIT	IONS	MIN	TYP	MAX	UNITS	
Dropout Voltage (Note 2)	\/\/.o	AV/0.17 0.19/	I _{OUT} = 5mA		0.06	0.2	<u> </u>	
Dropout Voltage (Note 3)	AIM - AOOI	$\Delta V_{OUT} = 0.1\%$	$I_{OUT} = 10mA$		0.12	0.4	V	
OUT Short-Circuit Current	la a	Short to GND			160		mA	
OUT Short-Circuit Current	Isc	Short to IN			20		MA	
Thermal I hystoresis (Note 2)	ΔV _{OUT} /	SO			35		10.10.100	
Thermal Hysteresis (Note 2)	cycle	μΜΑΧ			80		ppm	
Long Torm Stability	ΔV _{OUT} /	1000br at T 25°C	SO		20		ppm/	
Long-Term Stability	time	1000hr at $T_A = +25^{\circ}C$	μΜΑΧ		100		1000hr	
DYNAMIC CHARACTERISTICS								
		f = 0.1Hz to $10Hz$			1.45		μV _{P-P}	
Noise Voltage	eout	$f = 1kHz, C_{NR} = 0$		75				
		$f = 1kHz$, $C_{NR} = 0.1\mu F$	45			nV/√Hz		
Turn On Cottling Times	4-	To V _{OUT} = 0.01% of	$C_{NR} = 0$		1			
Turn-On Settling Time	t _R	final value	$C_{NR} = 0.1 \mu F$		20		ms	
Capacitive-Load Stability Range	CLOAD	No sustained oscillation	S		0.1 to 10		μF	
INPUT								
Supply Voltage Range	VIN	Guaranteed by line-regulation test		2.7		12.6	V	
Outcoast Cussly Cussest	I _{IN}	T _A = +25°C			380	550	μA	
Quiescent Supply Current		$T_A = -40^{\circ}C \text{ to } +125^{\circ}C$			725			

ELECTRICAL CHARACTERISTICS—MAX6126_28 (Vout = 2.800V)

 $(V_{IN} = 5V, C_{LOAD} = 0.1 \mu F, I_{OUT} = 0, T_A = T_{MIN}$ to T_{MAX} , unless otherwise noted. Typical values are at $T_A = +25 ^{\circ}C$.)

PARAMETER	SYMBOL	CONDTIO	MIN	TYP	MAX	UNITS	
ОUТРUТ							
Output Voltage	Vout	T _A = +25°C			2.800		V
Output Voltage Accuracy		Referred to VOUT, T _A =	A grade µMAX	-0.06		+0.06	- %
		+25°C	B grade µMAX	-0.10		+0.10	76
Output Voltage Temperature Coefficient (Note 1)		$T_A = -40^{\circ}\text{C} \text{ to } +85^{\circ}\text{C}$	A grade µMAX		1	3	
	TO\/	1A = -40 C 10 +65 C	B grade µMAX		2	7	ppm/°C
	TCV _{OUT}	$T_A = -40^{\circ}C \text{ to } +125^{\circ}C$	A grade µMAX		2	5	
			B grade µMAX		3	12	
			$T_A = +25^{\circ}C$		3.5	23	μV/V
Line Regulation	ΔV _{OUT} /ΔV _{IN}	$3.0V \le V_{1N} \le 12.6V$	$T_A = -40^{\circ}C$ to $+125^{\circ}C$			45	
Load Degulation	A\//A\/	Sourcing: 0 ≤ I _{OUT} ≤ 10m	nA		1.3	28	\ //ww A
Load Regulation	ΔV _{OUT} /ΔV _{IN}	Sinking: -10mA ≤ I _{OUT} ≤	Sinking: -10mA ≤ I _{OUT} ≤ 0		2.4	28	μV/mA
Draggett Voltage (Nata 2)	., .,	AV/ 0.10/	I _{OUT} = 5mA		0.06	0.2	V
Dropout Voltage (Note 3)	V _{IN} - V _{OUT}	$\Delta V_{OUT} = 0.1\%$	I _{OUT} = 10mA		0.12	0.4	

ELECTRICAL CHARACTERISTICS—MAX6126_28 (VOUT = 2.800V) (continued)

 $(V_{IN} = 5V, C_{LOAD} = 0.1 \mu F, I_{OUT} = 0, T_A = T_{MIN}$ to T_{MAX} , unless otherwise noted. Typical values are at $T_A = +25$ °C.)

PARAMETER	SYMBOL	CONDTIC	MIN	TYP	MAX	UNITS	
OLIT Chart Circuit Current	la a	Short to GND		160			
OUT Short-Circuit Current	I _{SC}	Short to IN		20		mA	
Thermal Hysteresis (Note 2)	ΔV _{OUT} /cycle	μΜΑΧ			80		ppm
Long-Term Stability	ΔV _{OUT} /time	1000hr at T _A = +25°C μMAX			100		ppm/ 1000hr
DYNAMIC CHARACTERISTICS							
		f = 0.1Hz to 10Hz		1.45			μV _{P-P}
Noise Voltage	eout	$f = 1kHz, C_{NR} = 0$		75			
		$f = 1kHz$, $C_{NR} = 0.1\mu F$	45			- nV/√Hz	
Turn On Cottling Time	4_	To V _{OUT} = 0.01% of	C _{NR} = 0	1			
Turn-On Settling Time	t _R	final value	$C_{NR} = 0.1 \mu F$		20		ms
Capacitive-Load Stability Range	CLOAD	No sustained oscillations	3		0.1 to 10		μF
INPUT							
Supply Voltage Range	VIN	Guaranteed by line-regu	3.0		12.6	V	
Outles a set County Coursest		T _A = +25°C		380	550	μА	
Quiescent Supply Current	IIN	$T_A = -40^{\circ}C \text{ to } +125^{\circ}C$		•	725		

ELECTRICAL CHARACTERISTICS—MAX6126_30 (Vout = 3.000V)

 $(V_{IN} = 5V, C_{LOAD} = 0.1 \mu F, I_{OUT} = 0, T_A = T_{MIN}$ to T_{MAX} , unless otherwise noted. Typical values are at $T_A = +25 ^{\circ}C$.)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
OUTPUT							
Output Voltage	Vout	T _A = +25°C			3.000		V
			A grade SO	-0.02		+0.02	
Output Voltage Accuracy		Referred to Vout,	B grade SO	-0.06		+0.06	%
		$T_A = +25$ °C	A grade µMAX	-0.06		+0.06	%
			B grade µMAX	-0.1		+0.1	
		T _A = -40°C to +85°C	A grade SO		0.5	3	ppm/°C
			B grade SO		1	5	
			A grade µMAX		1	3	
Output Voltage Temperature	TOV		B grade µMAX		2	7	
Coefficient (Note 1)	TCV _{OUT}		A grade SO		1	5	
		$T_A = -40$ °C to	B grade SO		2	10	
		+125°C	A grade µMAX		2	5	
			B grade μMAX		3	12	

ELECTRICAL CHARACTERISTICS—MAX6126_30 (Vout = 3.000V) (continued)

 $(V_{IN} = 5V, C_{LOAD} = 0.1 \mu F, I_{OUT} = 0, T_A = T_{MIN}$ to T_{MAX} , unless otherwise noted. Typical values are at $T_A = +25 ^{\circ}C$.)

PARAMETER	SYMBOL	CON	IDITI	ONS	MIN	TYP	MAX	UNITS	
Line Regulation	ΔV _{OUT} /	$3.2V \le V_{ N } \le 12.6V$	Тд	. = +25°C		4	25	μV/V	
Line negulation	ΔV_{IN}	3.2V ≤ V N ≤ 12.0V	Тд	$L = -40^{\circ}C \text{ to } +125^{\circ}C$			50	μν/ν	
Load Regulation	ΔV _{OUT} /	Sourcing: 0 ≤ I _{OUT} ≤	≤ 10r	nA		1.5	30	μV/mA	
Load Negulation	Δlout	Sinking: -10mA ≤ I _O	UT≤	0		2.8	30	μν/πΑ	
Dropout Voltage (Note 3)	V _{IN} - V _{OUT}	$\Delta V_{OUT} = 0.1\%$	Ю	UT = 5mA		0.06	0.2	V	
Diopout Voltage (Note 3)	VIN - VOUT	$\Delta V \cup U = 0.1\%$	lo	UT = 10mA		0.11	0.4	V	
OUT Short-Circuit Current	laa	Short to GND				160		mA	
COT Short-Circuit Current	Isc	Short to IN				20		MA	
Thermal Hystorogia (Note 2)	ΔV _{OUT} /	SO		20		ppm			
Thermal Hysteresis (Note 2)	cycle	μΜΑΧ			80				
Long Torm Stability	ΔV _{OUT} /	1000br at T 05%		SO		20		ppm/	
Long-Term Stability	time	1000hr at $T_A = +25^\circ$		μΜΑΧ		100		1000hr	
DYNAMIC CHARACTERISTICS									
		f = 0.1Hz to 10Hz			1.75		μV _{P-P}		
Noise Voltage	eout	$f = 1kHz$, $C_{NR} = 0$			90			>///	
		$f = 1kHz$, $C_{NR} = 0.1\mu F$			55			nV/√Hz	
Capacitive-Load Stability Range	CLOAD	No sustained oscilla	ations	3		0.1 to 10		μF	
Turne On Cataline Time		To V _{OUT} = 0.01%	C۱	NR = 0		1.2			
Turn-On Settling Time	t _R	of final value	C۱	NR = 0.1μF		20		ms	
INPUT									
Supply Voltage Range	V _{IN}	Guaranteed by line-regulation test		3.2		12.6	V		
Outro a serie Comente Comente		T _A = +25°C			380	550	0		
Quiescent Supply Current	I _{IN}	$T_A = -40^{\circ}C \text{ to } +125^{\circ}C$					725	μA	

ELECTRICAL CHARACTERISTICS—MAX6126_41 (Vout = 4.096V)

 $(V_{IN}=5V,\,C_{LOAD}=0.1\mu\text{F},\,I_{OUT}=0,\,T_{A}=T_{MIN}\,to\,T_{MAX},\,unless\,otherwise\,noted.\,Typical\,values\,are\,at\,T_{A}=+25^{\circ}C.)$

PARAMETER	SYMBOL	CON	MIN	TYP MAX	UNITS	
ОUТРUТ						
Output Voltage	Vout	T _A = +25°C			4.096	V
Output Voltage Accuracy			A grade SO	-0.02	+0.02	
		Referred to V_{OUT} , $T_A = +25^{\circ}C$	B grade SO	-0.06	+0.06	%
			A grade µMAX	-0.06	+0.06	
			B grade µMAX	-0.1	+0.1	

ELECTRICAL CHARACTERISTICS—MAX6126_41 (Vout = 4.096V) (continued)

 $(V_{IN} = 5V, C_{LOAD} = 0.1 \mu F, I_{OUT} = 0, T_A = T_{MIN} \text{ to } T_{MAX}, \text{ unless otherwise noted. Typical values are at } T_A = +25 ^{\circ}C.)$

PARAMETER	SYMBOL	CONE	DITIONS	MIN	TYP	MAX	UNITS	
			A grade SO		0.5	3	ppm/°C	
		$T_A = -40^{\circ}C$ to	B grade SO		1	5		
		+85°C	A grade µMAX		1	3		
Output Voltage Temperature	TOV		B grade µMAX		2	7		
Coefficient (Note 1)	TCV _{OUT}		A grade SO		1	5		
		$T_A = -40^{\circ}C$ to	B grade SO		2	10		
		+125°C	A grade µMAX		2	5		
			B grade µMAX		3	12		
Line Demoletien	ΔV _{OUT} /	4.0)/ // 40.0)/	T _A = +25°C		4.5	30	μV/V	
Line Regulation	ΔVIN	$4.3V \le V_{\text{IN}} \le 12.6V$	$T_A = -40^{\circ}C \text{ to } +125^{\circ}C$			60		
Lood Dogwlation	ΔV _{OUT} /	Sourcing: 0 ≤ I _{OUT} ≤	10mA		2	40	μV/mA	
Load Regulation	Δ lout	Sinking: -10mA ≤ I _{OU}	T ≤ 0		5	40		
D (1) (1) (1)	V _{IN} - V _{OUT}	$\Delta V_{OUT} = 0.1\%$	I _{OUT} = 5mA		0.05	0.2	V	
Dropout Voltage (Note 3)			I _{OUT} = 10mA		0.1	0.4		
OLIT Chart Circuit Current	1	Short to GND			160		mA	
OUT Short-Circuit Current	Isc	Short to IN			20			
The arrange (Nichola)	ΔV _{OUT} /	SO			20			
Thermal Hysteresis (Note 2)	cycle	μMAX			80		ppm	
Lange Tarres Obale Site	ΔV _{OUT} /	1000b; -t T 0500	SO		20		ppm/	
Long-Term Stability	time	1000hr at T _A = +25°C μ MAX			100		1000hr	
DYNAMIC CHARACTERISTICS			<u> </u>					
		f = 0.1Hz to 10Hz			2.4		μV _{P-P}	
Noise Voltage	eout	$f = 1kHz$, $C_{NR} = 0$		120				
		$f = 1kHz, C_{NR} = 0.1\mu$	f = 1kHz, C _{NR} = 0.1μF		80		nV/√Hz	
Capacitive-Load Stability Range	CLOAD	No sustained oscillations			0.1 to 10		μF	
T. O.O.W. T.		To V _{OUT} = 0.01% of	C _{NR} = 0		1.6			
Turn-On Settling Time	t _R	final value	$C_{NR} = 0.1 \mu F$		20		ms	
INPUT								
Supply Voltage Range	V _{IN}	Guaranteed by line-re	egulation test	4.3		12.6	V	
Ouissant Cumply Current	l	T _A = +25°C			380	550		
Quiescent Supply Current	IIN	$T_A = -40^{\circ}\text{C to } + 125^{\circ}\text{C}$				725	μΑ	

ELECTRICAL CHARACTERISTICS—MAX6126_50 (Vout = 5.000V)

 $(V_{IN} = 5.5V, C_{LOAD} = 0.1 \mu F, I_{OUT} = 0, T_A = T_{MIN} \text{ to } T_{MAX}, \text{ unless otherwise noted. Typical values are at } T_A = +25 ^{\circ}C.)$

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS	
OUTPUT								
Output Voltage	Vout	T _A = +25°C			5.000		V	
			A grade SO	-0.02		+0.02	%	
Output Voltage Accuracy			B grade SO	-0.06		+0.06		
Output Voltage Accuracy		$T_A = +25^{\circ}C$	A grade μMAX	-0.06		+0.06		
			B grade μMAX	-0.1		+0.1		
			A grade SO		0.5	3		
		$T_A = -40^{\circ}\text{C to } +85^{\circ}\text{C}$	B grade SO		1	5		
		1A = -40 C 10 +65 C	A grade µMAX		1	3		
Output Voltage Temperature	TCV _{OUT}		B grade μMAX		2	7	nnm/°C	
Coefficient (Note 1)	10,001		A grade SO		1	5	ppm/°C	
		$T_A = -40^{\circ}C$ to	B grade SO		2	10		
		+125°C	A grade μMAX		2	5		
			B grade μMAX		3	12	<u> </u>	
Line Regulation	ΔV _{OUT} / ΔV _{IN}	5.2V ≤ V _{IN} ≤ 12.6V	T _A = +25°C		3	40	μV/V	
			$T_A = -40^{\circ}C \text{ to } +125^{\circ}C$			80		
1 15 16	ΔV _{OUT} /	Sourcing: 0 ≤ I _{OUT} ≤ 10mA			2.5	50	μV/mA	
Load Regulation	Δlout	Sinking: -10mA ≤ I _{OU}	T ≤ 0		6.5	50	μν/πΑ	
Dropout Voltage (Note 3)	V _{IN} - V _{OUT}	$\Delta V_{OUT} = 0.1\%$	I _{OUT} = 5mA		0.05	0.2	V	
Diopout voltage (Note 3)		AV001 = 0.178	I _{OUT} = 10mA		0.1	0.4		
OUT Short-Circuit Current	loo	Short to GND			160		mA	
OOT Short-Circuit Current	Isc	Short to IN			20		IIIA	
Thermal Hysteresis (Note 2)	ΔV _{OUT} /	SO			15 80		ppm	
memai riysteresis (Note 2)	cycle	μMAX						
Long-Term Stability	ΔV _{OUT} /	1000br at T ₄ = +25°C	SO		20		ppm/	
Long-Term Stability	time	1000hr at T _A = +25°C μ MAX			100		1000hr	
DYNAMIC CHARACTERISTICS	T	1					1	
		f = 0.1Hz to 10Hz			2.85		μV _{P-P}	
Noise Voltage	eout	$f = 1kHz, C_{NR} = 0$			145		nV/√Hz	
		$f = 1kHz$, $C_{NR} = 0.1\mu F$			95		, , , , ,	
Capacitive-Load Stability Range	CLOAD	No sustained oscillations			0.1 to 10		μF	

NIXIN

ELECTRICAL CHARACTERISTICS—MAX6126 50 (VOUT = 5.000V) (continued)

 $(V_{IN} = 5.5V, C_{LOAD} = 0.1 \mu F, I_{OUT} = 0, T_A = T_{MIN}$ to T_{MAX} , unless otherwise noted. Typical values are at $T_A = +25$ °C.)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP	MAX	UNITS
Turn-On Settling Time		To V _{OUT} = 0.01% of final value	$C_{NR} = 0$		2		
	tR		$C_{NR} = 0.1 \mu F$		20		ms
INPUT							
Supply Voltage Range	V _{IN}	Guaranteed by line-regulation test		5.2		12.6	V
Outcomet Cumply Cumpet	I	T _A = +25°C			380	550	
Quiescent Supply Current	IIN	$T_A = -40^{\circ}C \text{ to } +125^{\circ}C$				725	μΑ

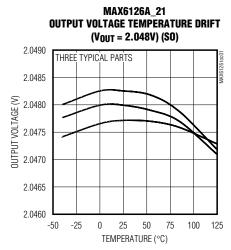
Note 1: Temperature coefficient is measured by the "box" method, i.e., the maximum ΔV_{OUT} / V_{OUT} is divided by the maximum ΔT.

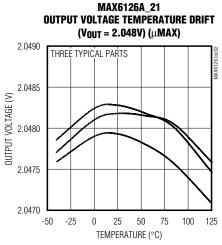
Note 2: Thermal hysteresis is defined as the change in +25°C output voltage before and after cycling the device from T_{MAX} to T_{MIN}.

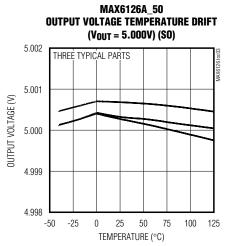
Note 3: Dropout voltage is defined as the minimum differential voltage $(V_{IN} - V_{OUT})$ at which V_{OUT} decreases by 0.1% from its original value at $V_{IN} = 5.0 \text{V}$ ($V_{IN} = 5.5 \text{V}$ for $V_{OUT} = 5.0 \text{V}$).

Typical Operating Characteristics

 $(V_{IN} = 5V \text{ for MAX6126_21/25/30/41}, V_{IN} = 5.5V \text{ for MAX6126_50}, C_{LOAD} = 0.1 \mu F, I_{OUT} = 0, T_A = +25 ^{\circ}C, unless otherwise specified.) (Note 5)$

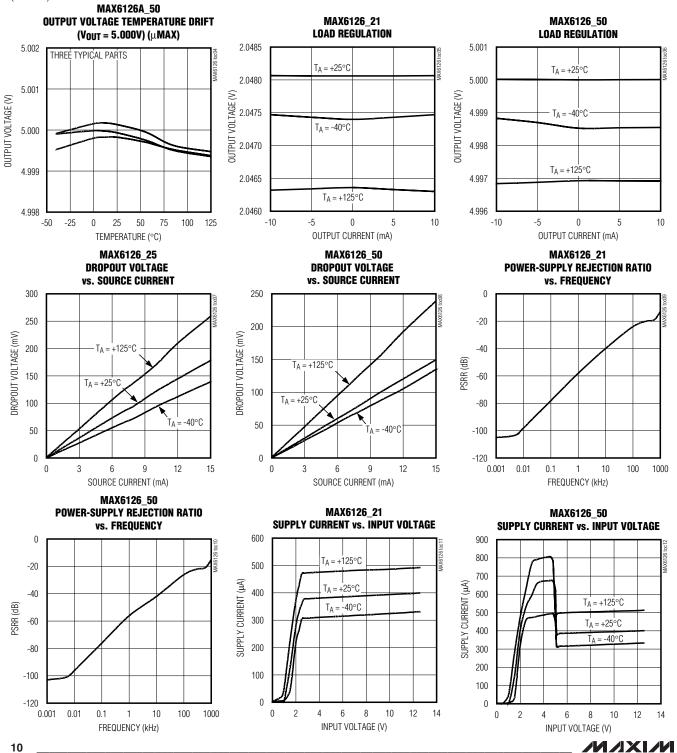






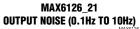
Typical Operating Characteristics (continued)

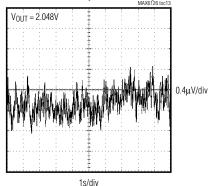
 $(V_{IN} = 5V \text{ for MAX6126_21/25/30/41}, V_{IN} = 5.5V \text{ for MAX6126_50}, C_{LOAD} = 0.1 \mu F, I_{OUT} = 0, T_A = +25 ^{\circ}C, unless otherwise specified.) (Note 5)$



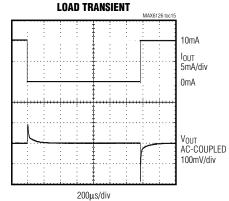
Typical Operating Characteristics (continued)

 $(V_{IN} = 5V \text{ for MAX6126_21/25/30/41}, V_{IN} = 5.5V \text{ for MAX6126_50}, C_{LOAD} = 0.1 \mu F, I_{OUT} = 0, T_A = +25 ^{\circ}C, unless otherwise specified.) (Note 5)$



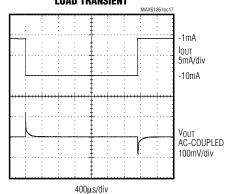


MAX6126_21



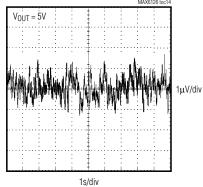
$$\begin{split} C_{LOAD} = 0.1 \mu F & \quad I_{OUT} = 0 \text{ TO 10mA} \\ V_{IN} = 5 V & \quad V_{OUT} = 2.048 V \end{split}$$

MAX6126_21 Load transient

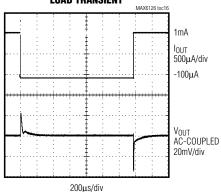


 $\begin{array}{cc} C_{LOAD} = 0.1 \mu F & i_{OUT} = -1 mA \ TO \ -10 mA \\ V_{IN} = 5 V & V_{OUT} = 2.048 V \end{array} \label{eq:closed}$

MAX6126_50 Output noise (0.1Hz to 10Hz)

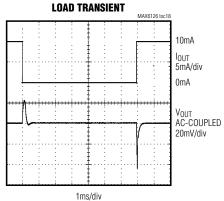


MAX6126_21 Load transient



 $C_{LOAD} = 0.1 \mu F$ $I_{OUT} = -100 \mu A TO 1 mA$ $V_{IN} = 5 V$ $V_{OUT} = 2.048 V$

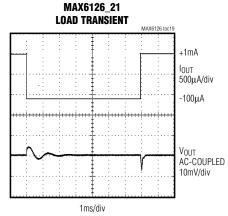
MAX6126_21



 $\begin{array}{ll} C_{LOAD} = 10 \mu F & \quad I_{OUT} = 0 \text{ TO } 10 \text{mA} \\ V_{IN} = 5 V & \quad V_{OUT} = 2.048 V \end{array}$

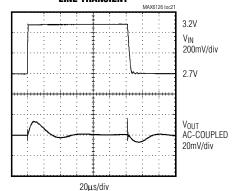
Typical Operating Characteristics (continued)

 $(V_{IN} = 5V \text{ for MAX6126_21/25/30/41}, V_{IN} = 5.5V \text{ for MAX6126_50}, C_{LOAD} = 0.1 \mu F, I_{OUT} = 0, T_A = +25 ^{\circ}C, unless otherwise specified.) (Note 5)$



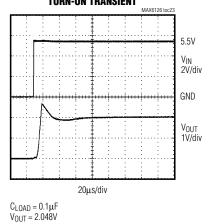
 $C_{LOAD} = 10 \mu F$ $I_{OUT} = -100 \mu A TO 1 mA$ $V_{IN} = 5 V$ $V_{OUT} = 2.048 V$

MAX6126_21 Line transient

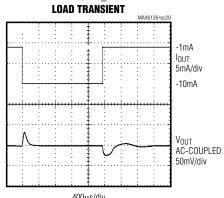


 $V_{OUT} = 2.048V \qquad C_{LOAD} = 0.1 \mu F$

MAX6126_21 Turn-on transient

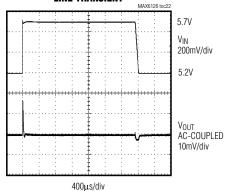


MAX6126_21



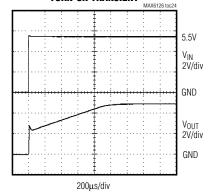
 $C_{LOAD} = 10 \mu F$ $I_{OUT} = -1 mA TO -10 mA$ $V_{IN} = 5 V$ $V_{OUT} = 2.048 V$

MAX6126_50 LINE TRANSIENT



 $\begin{array}{ll} V_{IN} = 5.2 V \; TO \; 5.7 V & C_{LOAD} = 0.1 \mu F \\ V_{OUT} = 5 V & \end{array} \label{eq:vin}$

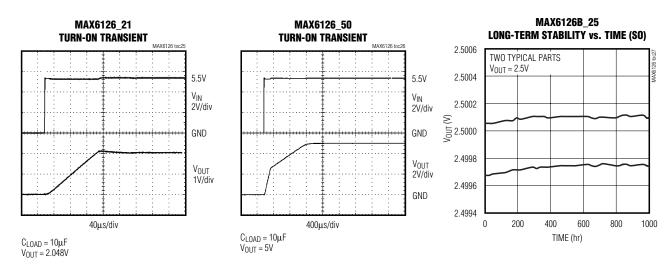
MAX6126_50 Turn-on transient

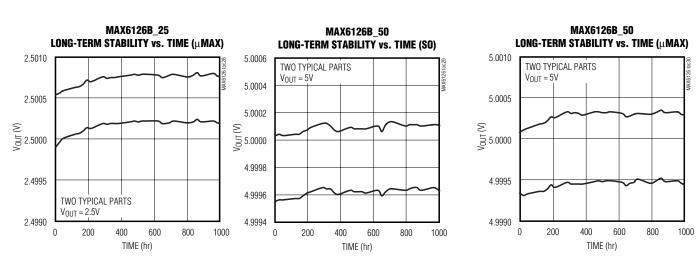


 $\begin{array}{l} C_{LOAD} = 0.1 \mu F \\ V_{OUT} = 5 V \end{array}$

Typical Operating Characteristics (continued)

 $(V_{IN} = 5V \text{ for MAX6126_21/25/30/41}, V_{IN} = 5.5V \text{ for MAX6126_50}, C_{LOAD} = 0.1 \mu F, I_{OUT} = 0, T_A = +25 ^{\circ}C, unless otherwise specified.) (Note 5)$





Note 5: Many of the MAX6126 *Typical Operating Characteristics* are extremely similar. The extremes of these characteristics are found in the MAX6126_21 (2.048V output) and the MAX6126_50 (5.000V output). The *Typical Operating Characteristics* of the remainder of the MAX6126 family typically lie between those two extremes and can be estimated based on their output voltages.

Pin Description

PIN	NAME	FUNCTION
1	NR	Noise Reduction. Connect a 0.1µF capacitor to improve wideband noise. Leave unconnected if not used (see Figure 1).
2	IN	Positive Power-Supply Input
3	GND	Ground
4	GNDS	Ground-Sense Connection. Connect to ground connection at load.
5, 8	I.C.	Internally Connected. Do not connect anything to these pins.
6	OUTS	Voltage Reference Sense Output
7	OUTF	Voltage Reference Force Output. Short OUTF to OUTS as close to the load as possible. Bypass OUTF with a capacitor (0.1µF to 10µF) to GND.

Detailed Description

Wideband Noise Reduction

To improve wideband noise and transient power-supply noise, add a 0.1µF capacitor to NR (Figure 1). Larger values do not improve noise appreciably. A 0.1µF NR capacitor reduces the noise from $60\text{nV}/\sqrt{\text{Hz}}$ to $35\text{nV}/\sqrt{\text{Hz}}$ for the 2.048V output. Noise in the power-supply input can affect output noise, but can be reduced by adding an optional bypass capacitor between IN and GND, as shown in the *Typical Operating Circuit*.

Output Bypassing

The MAX6126 requires an output capacitor between 0.1 μ F and 10 μ F. Locate the output capacitor as close to OUTF as possible. For applications driving switching capacitive loads or rapidly changing load currents, it is advantageous to use a 10 μ F capacitor in parallel with a 0.1 μ F capacitor. Larger capacitor values reduce transients on the reference output.

Supply Current

The quiescent supply current of the series-mode MAX6126 family is typically 380µA and is virtually independent of the supply voltage, with only a 2µA/V (max) variation with supply voltage.

When the supply voltage is below the minimum specified input voltage during turn-on, the device can draw

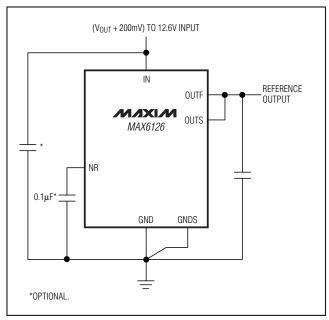


Figure 1. Noise-Reduction Capacitor

up to 300µA beyond the nominal supply current. The input voltage source must be capable of providing this current to ensure reliable turn-on.

Thermal Hysteresis

Thermal hysteresis is the change of output voltage at $T_A = +25$ °C before and after the device is cycled over its entire operating temperature range. The typical thermal hysteresis value is 20ppm (SO package).

Turn-On Time

These devices typically turn on and settle to within 0.1% of their final value in 200 μ s to 2ms depending on the device. The turn-on time can increase up to 4ms with the device operating at the minimum dropout voltage and the maximum load. A noise reduction capacitor of 0.1 μ F increases the turn-on time to 20ms.

Output Force and Sense

The MAX6126 provides independent connections for the power-circuit output (OUTF) supplying current into a load, and for the circuit input regulating the voltage applied to that load (OUTS). This configuration allows for the cancellation of the voltage drop on the lines connecting the MAX6126 and the load. When using the Kelvin connection made possible by the independent current and voltage connections, take the power connection to the load from OUTF, and bring a line from OUTS to join the line from OUTF, at the point where the voltage accu-

racy is needed. The MAX6126 has the same type of Kelvin connection to cancel drops in the ground return line. Connect the load to ground and bring a connection from GNDS to exactly the same point.

Applications Information

Precision Current Source

Figure 2 shows a typical circuit providing a precision current source. The OUTF output provides the bias current for the bipolar transistor. OUTS and GNDS sense the voltage across the resistor and adjust the current sourced by OUTF accordingly. For even higher precision, use a MOSFET to eliminate base current errors.

High-Resolution DAC and Reference from a Single Supply

Figure 3 shows a typical circuit providing the reference for a high-resolution, 16-bit MAX541 D/A converter.

Temperature Coefficient vs. Operating Temperature Range for a 1 LSB Maximum Error

In a data converter application, the reference voltage of the converter must stay within a certain limit to keep the error in the data converter smaller than the resolution limit through the operating temperature range. Figure 4 shows the maximum allowable reference voltage temperature coefficient to keep the conversion error to less than 1 LSB, as a function of the operating temperature range (TMAX - TMIN) with the converter resolution as a parameter. The graph assumes the reference voltage temperature coefficient as the only parameter affecting accuracy.

In reality, the absolute static accuracy of a data converter is dependent on the combination of many parameters such as integral nonlinearity, differential nonlinearity, offset error, gain error, as well as voltage reference changes.

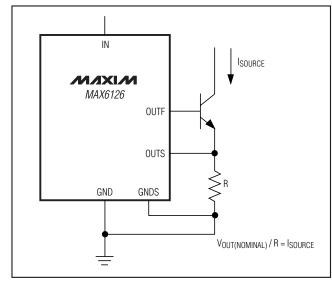


Figure 2. Precision Current Source

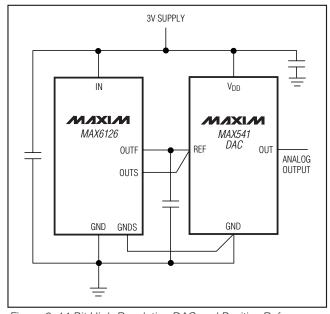


Figure 3. 14-Bit High-Resolution DAC and Positive Reference from a Single 3V Supply

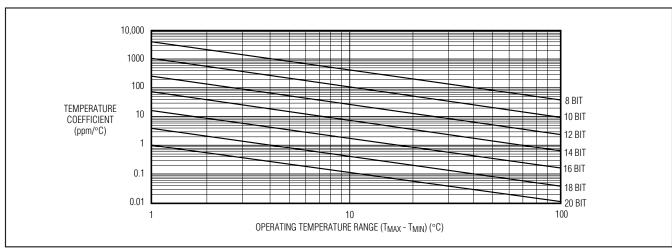
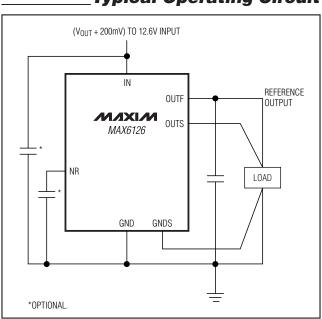


Figure 4. Temperature Coefficient vs. Operating Temperature Range for a 1 LSB Maximum Error

Typical Operating Circuit

Chip Information



PROCESS: BiCMOS

Ordering Information (continued)

PART	TEMP RANGE	PIN- PACKAGE	OUTPUT VOLTAGE (V)	MAXIMUM INITIAL ACCURACY (%)	MAXIMUM TEMPCO (-40°C to +85°C) (ppm/°C)	TOP MARK
MAX6126B21+	-40°C to +125°C	8 µMAX	2.048	0.1	7	6126B21
MAX6126AASA25+	-40°C to +125°C	8 SO	2.500	0.02	3	_
MAX6126BASA25+	-40°C to +125°C	8 SO	2.500	0.06	5	
MAX6126A25+	-40°C to +125°C	8 µMAX	2.500	0.06	3	6126A25
MAX6126B25+	-40°C to +125°C	8 µMAX	2.500	0.1	7	6126B25
MAX6126A28+	-40°C to +125°C	8 µMAX	2.800	0.06	3	6126A28
MAX6126B28+	-40°C to +125°C	8 µMAX	2.800	0.1	7	6126B28
MAX6126AASA30+	-40°C to +125°C	8 SO	3.000	0.02	3	
MAX6126BASA30+	-40°C to +125°C	8 SO	3.000	0.06	5	
MAX6126A30+	-40°C to +125°C	8 µMAX	3.000	0.06	3	6126A30
MAX6126B30+	-40°C to +125°C	8 µMAX	3.000	0.1	7	6126B30
MAX6126AASA41+	-40°C to +125°C	8 SO	4.096	0.02	3	_
MAX6126BASA41+	-40°C to +125°C	8 SO	4.096	0.06	5	_
MAX6126A41+	-40°C to +125°C	8 µMAX	4.096	0.06	3	6126A41
MAX6126B41+	-40°C to +125°C	8 µMAX	4.096	0.1	7	6126B41
MAX6126AASA50+	-40°C to +125°C	8 SO	5.000	0.02	3	_
MAX6126BASA50+	-40°C to +125°C	8 SO	5.000	0.06	5	
MAX6126A50+	-40°C to +125°C	8 µMAX	5.000	0.06	3	6126A50
MAX6126B50+	-40°C to +125°C	8 µMAX	5.000	0.1	7	6126B50

⁺Denotes a lead(Pb)-free/RoHS-compliant package.

Package Information

For the latest package outline information and land patterns, go to **www.maxim-ic.com/packages**. Note that a "+", "#", or "-" in the package code indicates RoHS status only. Package drawings may show a different suffix character, but the drawing pertains to the package regardless of RoHS status.

PACKAGE TYPE	PACKAGE CODE	OUTLINE NO.	LAND PATTERN NO.
8 μMAX	U8+1	<u>21-0036</u>	90-0092
8 SO	S8+4	21-0041	90-0096

Revision History

REVISION NUMBER	REVISION DATE	DESCRIPTION	PAGES CHANGED
0	10/02	Initial release	_
1	3/03	Remove "future product" and "contact factory" notes	1, 16
2	6/03	Add "A" grade devices	1, 16
3	12/03	Change µMAX part number	1, 16
4	7/04	Add top mark to Ordering Information	1, 16
5	12/10	Add 2.8V option, add lead-free options, update Package Information	1, 2, 4, 15, 16

Maxim cannot assume responsibility for use of any circuitry other than circuitry entirely embodied in a Maxim product. No circuit patent licenses are implied. Maxim reserves the right to change the circuitry and specifications without notice at any time.